Plasma texturing on large-area industrial grade CZ silicon solar cells

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Plasma texturing on large-area industrial grade CZ silicon solar cells

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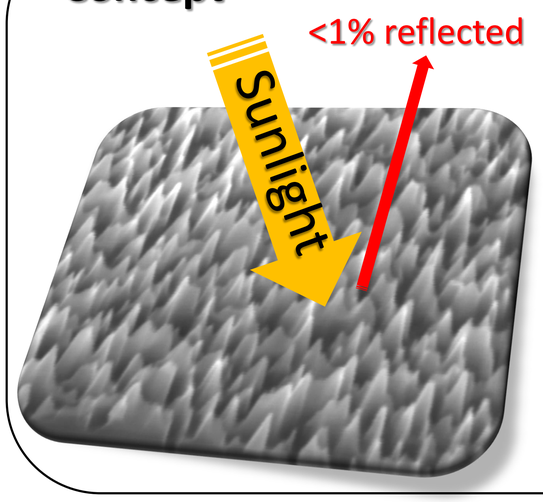
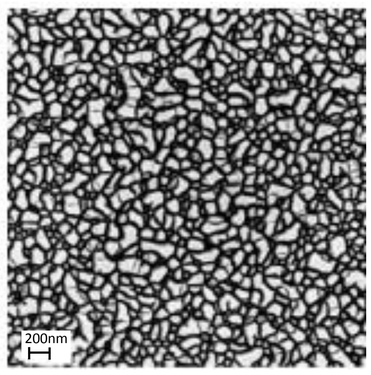
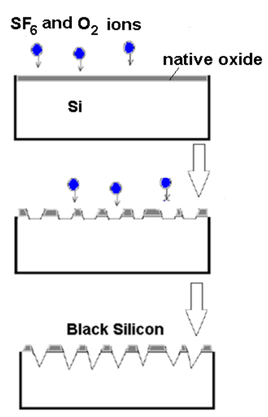
Concept



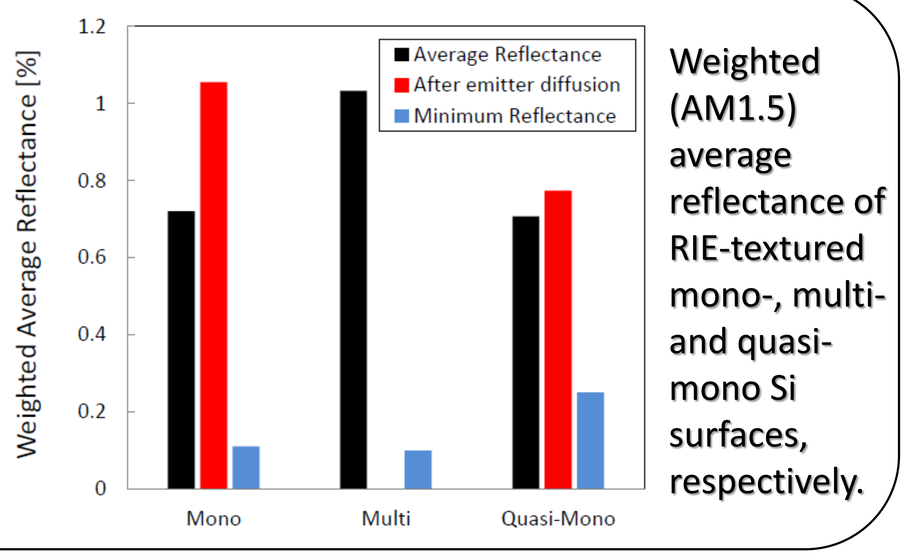


SEM-image (top-view) of the RIE-textured, nanostructured Si surface.



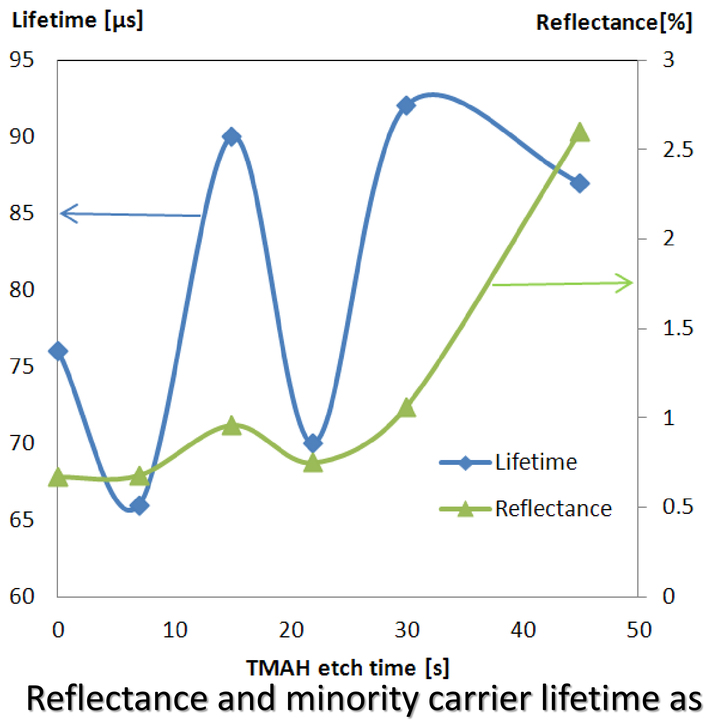
Nanostructures are fabricated by reactive ion etching (RIE) using SF_6 and O_2 ions.

The resulting Si surface is black and anti-reflective.



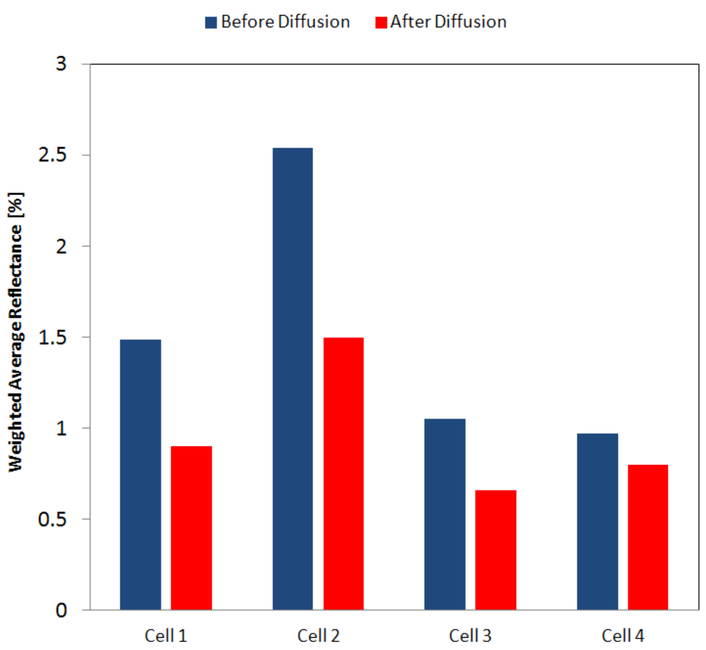
Weighted (AM1.5) average reflectance of RIE-textured mono-, multi- and quasi-mono Si surfaces, respectively.

Damage Removal Etch



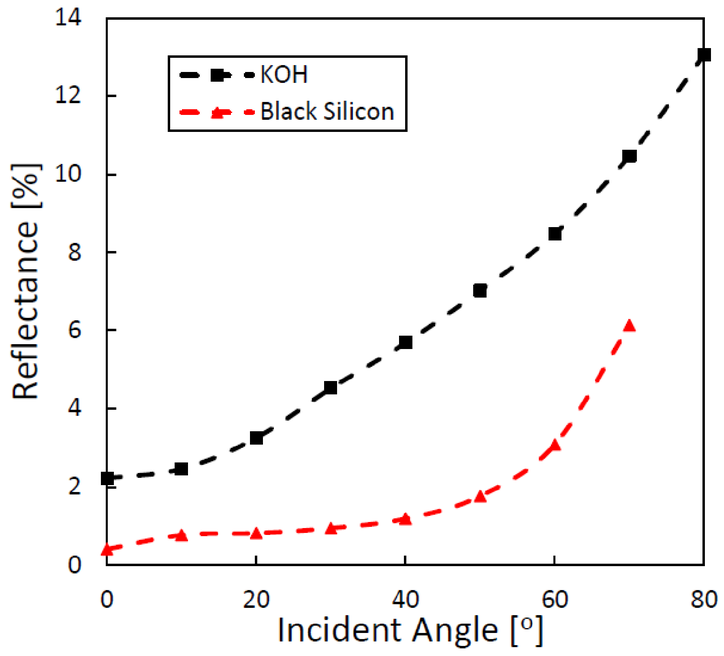
Reflectance and minority carrier lifetime as function of damage removal etch (DRE) time in 5% TMAH. Reflectance is kept below 1% for the first ≈30s of etching.

$POCl_3$ Emitter Diffusion



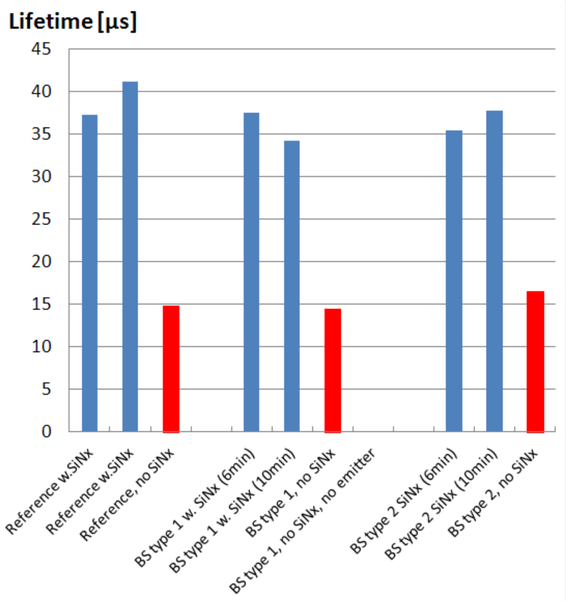
Weighted (AM1.5) average reflectance before and after emitter diffusion (150 Ω/sq.) for mono-crystalline Si with slightly different nanostructure texturing.

Varying incident angle



Weighted average reflectance as function of incident angle for a KOH-textured (squares) and RIE-textured (triangles) mono-c r Si substrates.

Carrier Lifetime



Minority carrier lifetime of RIE-textured Si wafers and a non-textured reference with and without PECVD SiN_x:H AR-coating, respectively. The measurement shows significant decrease in carrier lifetime if no SiN_x:H coating is applied. Furthermore, RIE-textured Si without emitter doping has carrier lifetime too low to be measured. The result confirms the need for passivation of RIE-textured cells.

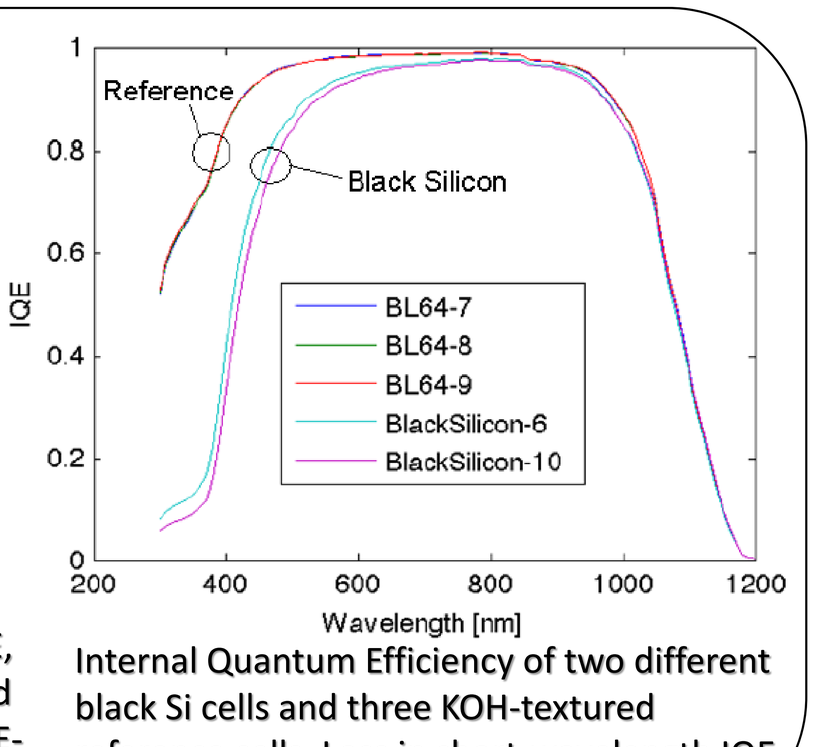
Electrical Results:

	Total Carrier Loss	Emitter recombination
KOH	1.385 mA/cm^2	0.761 mA/cm^2
RIE	4.163 mA/cm^2	3.322 mA/cm^2

Calculated total carrier loss and carrier loss due to emitter recombination for the KOH- and RIE-textured cell.

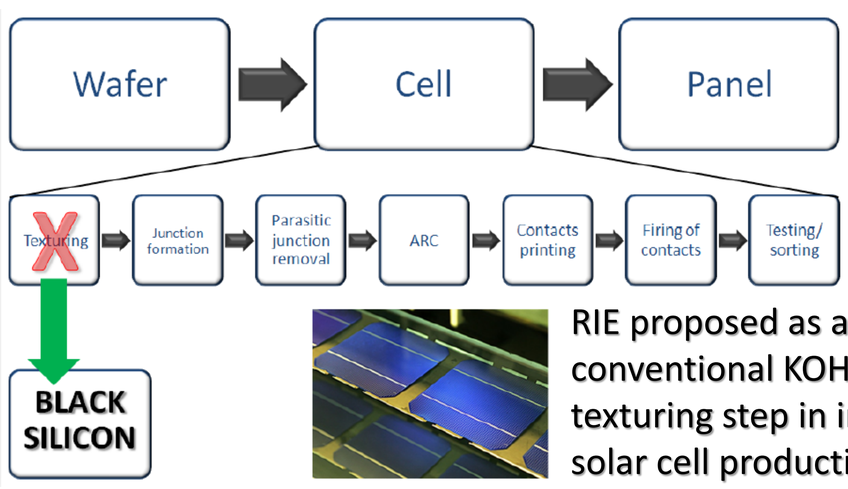
	PCE [%]	J_{SC} [mA/cm^2]	V_{OC} [V]	FF	R_{av} [%]
KOH	17.6	36.8	0.62	77.8	2-3
RIE, type 1	15.7	35.3	0.61	72.8	2.85
RIE, type 2	16.5	35.2	0.61	77.7	2.20

PV performance results including power conversion efficiency, PCE, short-circuit current, J_{SC}, open-circuit voltage, V_{OC}, fill factor, FF and weighted average reflectance after emitter diffusion, R_{av}, of the RIE- and KOH-textured cells.



Internal Quantum Efficiency of two different black Si cells and three KOH-textured reference cells. Loss in short-wavelength IQE indicates surface recombination.

Proposed Industrial Application:



RIE proposed as alternative to conventional KOH- and acidic texturing step in industrial solar cell production

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